spectrum the ordinary lines of oxygen and nitrogen are well seen. The silicium lines 4089·1 and 4116·4, denoted in the reproduction, are shown in the top spectrum, but they are entirely lacking in the air spectrum at the bottom. It would be remarkable that these lines, if really due to air, should not appear in the air spectrum itself. Moreover, the lines do not appear in the spark spectra of any of the chemical elements investigated other than silicium, although in all these the ordinary air lines are always well shown.

To sum up, the lines of Group IV have never been noted in any Kensington spectra without being accompanied by silicium lines of other groups, and they never appear unless silicium in some form or other is used in the light source furnishing the spectrum.

With regard to their identity with stellar lines, whatever their true terrestrial origin may be, there is scarcely any doubt. They agree exactly in wave-length with very strong lines in the spectra of the belt stars of Orion, and with less conspicuous lines in many other stellar spectra, for which no other satisfactory origin has been suggested.

"On Chemical Combination and Toxic Action as exemplified in Hæmolytic Sera."* By Robert Muir, M.D., Professor of Pathology, University of Glasgow, and Carl H. Browning, M.B., Ch.B., Carnegie Research Fellow, University of Glasgow. Communicated by Dr. C. J. Martin, F.R.S. Received November 10,—Read December 1, 1904.

It is now well known that the action of a hæmolytic serum depends upon two substances, viz.: (*a*) the immune-body, which is developed as the result of the injection of the red corpuscles of an animal of different species, and (*b*) the complement, a labile substance which is present in the serum of the normal animal, and which is not increased as the result of such injection. Ehrlich has pointed out the similarity in the constitution of complements and of various toxins, and our own observations strongly support his views. We may, in the study of hæmolysis, consider the complement as a toxin, the red corpuscles treated with the appropriate immune-body as the object on which the toxin is to act, and the hæmolysis as the indication of the toxic action. Ehrlich regards the complement as consisting of two chief atom-groups, the haptophore or combining group and the zymotoxic; but in speaking of the action of sera he does not always carry out this distinction completely. For example, the efficiency of different complements as tested by their hæmolytic or bacteriolytic effects is often taken as

* The expenses of this research were defrayed by a grant from the Carnegie Trustees.

evidence of the degree of chemical affinity between the complements and the immune-body. But it is manifest that theoretically a complement may combine perfectly through the medium of the immune-body, and yet produce little hæmolysis, owing to the absence of sensitiveness to the zymotoxic group—combination or "complementing" may occur and yet hæmolysis be deficient or absent. The question which we have investigated is accordingly this—Where different complements differ in their action as shown by the dosage, both of complement and of immune-body required, does this depend upon differences in their combining affinities or upon differences in their toxicity?

In working out this problem we have made use of three sera, viz.: (*a*) the serum of the rabbit injected with ox's corpuscles, therefore hæmolytic towards ox's corpuscles, (*b*) the serum of the rabbit injected with guinea-pig's corpuscles, (*c*) the serum of the guinea-pig injected with rabbit's corpuscles. In each case the hæmolytic serum is deprived of its complement by heating at 55° C. and, therefore, contains only immune-body; it is accordingly inactive until complement (*i.e.*, normal serum) is added.

In this and the other tables the following abbreviations are used: IB = immune body, and *v.* is placed before the name of the animal on whose corpuscles the immune-body acts, thus *IB rabbit v. guinea-pig* signifies the immune-body obtained from the rabbit, and acting on guinea-pig's corpuscles, C = complement, 1D = one hæmolytic dose (of IB or C as the case may be).

In the first place, we may give in tabular form, the average dosage of the several complements with the different immune sera: the test amount of corpuscles being 1 c.c. of a 5-per-cent. suspension in 0·8 per cent. sodium chloride solution.

Immune-body and corpuscles tested.	Rabbit's complement.	Guinea-pig's complement.	Ox's complement.
IB rabbit *v.* ox; Ox's corpuscles	0·15 c.c.	0·025 c.c.	∞
IB rabbit *v.* guinea-pig; Guinea-pig's corpuscles	0·15 "	**0·3** "	0·03 c.c.*
IB guinea-pig *v.* rabbit; Rabbit's corpuscles	**0·5** "	0·07 "	0·04 " *

* The normal serum of the ox has a strong hæmolytic action both on rabbit's and on guinea-pig's corpuscles. This is due to the presence of a natural immune-body, and it is not possible to remove this in the usual way by placing the serum in contact with the corpuscles at 0° C. We have, however, made allowance for this circumstance, and the dosage of complement has been calculated accordingly, and may be taken as substantially correct.

This table shows that in the cases studied the highest dosage of the complement of an animal occurs when used against its own corpuscles.

Dosage of Immune-bodies with different Complements.

Complement.	IB rabbit *v.* ox.	IB rabbit *v.* guinea-pig.	IB guinea-pig *v.* rabbit.
Rabbit's	0·003 c.c.	0·003 c.c.	0·15 c.c.
Guinea-pig's..............	0·003 ,,	0·03 ,,	0·015 ,,
Ox's.....................	∞	? *	0·02 ,,

The most striking facts brought out in this table concern the relative doses of immune-bodies with rabbit's and guinea-pig's complements respectively, they are (*a*) in the case of an immune-body acting on the corpuscles of another animal (viz., ox's corpuscles), its dose with rabbit's complement is practically the same as that with guinea-pig's complement; (*b*) when the immune-body acts on guinea-pig's corpuscles its dose is ten times greater with guinea-pig's complement than with rabbit's complement, and a converse statement obtains in the case of the immune-body to rabbit's corpuscles. It is also to be noted that the immune-body to ox's corpuscles does not bring about complete hæmolysis at all when the ox's complement is used.

These tables supply the hæmolytic doses of the different immune-bodies and complements; they do not, however, give us the facts with regard to their several combinations. In illustration of this we may mention that Ehrlich and Morgenroth,† finding that the dose of the immune-body to rabbit's corpuscles obtained from the guinea-pig was ten times higher (as shown in the table) when rabbit's complement was used than when guinea-pig's complement was used, supposed that there were really two immune-bodies, one present in large amount taking up guinea-pig's complement and another present in small quantity taking up rabbit's complement. This is manifestly a satisfactory theoretical explanation, but we have to enquire whether it is supported by facts.

We shall accordingly consider the amounts of complement taken up through the medium of different doses of immune-body in the several cases. It will be convenient to take first the second and third sera, as above arranged. The method employed for estimating the amount of

* We have not succeeded in getting a satisfactory estimation of the dose of this immune-body with ox's complement, owing to failure to remove the natural immune-body for guinea-pig's corpuscles in the ox's serum.

† Ehrlich and Morgenroth, 'Berlin. klin. Woch.,' 1900, No. 31.

complement taken up depends upon the firmness of union of complement, and has been described in former papers.*

I. *Immune-body to Guinea-pig's Corpuscles (obtained by injecting the Rabbit with these corpuscles).*

(a) *With Guinea-pig's Complement*—

We may first compare the results when guinea-pig's complement is used, with those when rabbit's complement is used. In the former case the dose of complement is very high; in fact, more than ten times the amount of guinea-pig's complement sufficient to hæmolyse ox's corpuscles, is necessary to hæmolyse its own corpuscles. This might be due to the fact that only a fraction of the complement molecules suited the immune-body to guinea-pig's corpuscles, or it might be due merely to weakness of toxic action of the complement. If the former were the case the presence of the uncombined complement would be shown by adding the corpuscles of another animal treated with the corresponding immune-body. The matter is put to the test by adding varying amounts of guinea-pig's complement to guinea-pig's corpuscles with their corresponding immune-body, and then after allowing 2 hours at 37° C. for combination, to test for the presence of complement by means of ox's corpuscles treated with their immune-body. If we use 1 D of immune-body to indicate the amount necessary to produce lysis when rabbit's complement is used, then 10 D will be the M.H.D. when guinea-pig's complement is used. The following are the chief results which we have obtained. It is to be noted that, of course, if less than 10 D is added complete lysis does not occur with guinea-pig's complement, and in such cases the tubes are centrifugalised and the clear fluid is added to the indicator, *i.e.*, ox's corpuscles treated with their immune-body. This indicator is specially suitable on account of the high sensitiveness of the corpuscles to guinea-pig's complement.

Such an experiment may be graphically represented thus—

$$\text{Guinea-pig's} \bigcirc + n\,\text{IB} + x \text{ guinea-pig's C} \;\vdots\; + \text{Ox's} \bigcirc + \text{IB}$$

the small circle indicating red corpuscles, the vertical dotted line a period of incubation at 37° C., n indicating a definite multiple of IB, and x varying amounts of C.

* Muir, 'The Lancet,' 1903, vol. 2, p. 446; and Muir and Browning, 'Roy. Soc. Proc.,' June 9, 1904.

IB Rabbit *v.* Guinea-pig. Guinea-pig's C.

Experiment XLII.—2 D of IB took up 0·08 c.c. guinea-pig's C.
8 " " 0·288 " "
Dose of guinea-pig's C = about 0·3 c.c.

" XLIII.—1 D of IB took up 0·026 c.c. guinea-pig's C.
5 " " 0·114 " "
10 " " 0·254 " "
Dose of C = 0·25 c.c.

" XLIV.—1 D of IB took up 0·014 c.c. guinea-pig's C.
14 " " 0·38 " "
Dose of C = 0·35 c.c.

" LXIX.—1 D of IB took up 0·04 c.c. guinea-pig's C.
5 " " 0·28 " "
10 " " 0·48 " "
Dose of C = 0·4 c.c.

From these results it is manifest that the large amount of guinea-pig's complement necessary to produce lysis, combines completely with the guinea-pig's corpuscles treated with the corresponding immune-body, there being, up to a certain point, no complement left over to act on the test corpuscles, and the large dose of immune-body necessary is simply due to this amount being required to bring the necessary complement into combination with the corpuscles. The guinea-pig's complement has, therefore, a *weak toxic action* on guinea-pig's corpuscles, about ten times weaker than it has, for example, on ox's corpuscles.

Note.—The amount of complement taken up is calculated from the point at which free complement is obtainable after time has been allowed for combination. It will be noticed that the amount of complement taken up is approximately, though not strictly, proportional to the amount of immune-body present. The divergence is more marked when higher multiples are used, as has been noted by one of us in the case of another combination; in other words, what is known as "Ehrlich's phenomenon," is seen to a slight extent. As, however, there is very little evidence of dissociation of complement after it has combined, the phenomenon in this case is probably due to presence of complementoid.

(b) *With Rabbit's Complement*—

It will be seen from the tables that (*a*) the M.H.D. of immune-body in this case is small—about a tenth of that necessary when guinea-pig's complement is used, and (*b*) that the dose of complement also is comparatively small, in fact, practically the same as that necessary for the hæmolysis of ox's corpuscles. In investigating the amount of rabbit's complement taken up by means of multiple doses of immune-body, interesting and at first very puzzling results emerged. An

experiment of this kind may be graphically represented as before, thus :—

Guinea-pig's ○ + *n* IB + *x* rabbit's C ⋮ Guinea-pig's ○ + IB.

In performing experiments of this kind we found that five or even ten doses of immune-body apparently led to the taking up of scarcely more complement than one dose of immune-body did; and further that the amount of complement apparently taken up seemed to become less, the longer the test corpuscles were left in the fluid. Thus, for example, at the end of 2 hours, 15 c.c. of complement might appear to be taken up, and next morning only ·05 c.c. It appeared, therefore, (*a*) that multiple doses of immune-body did not lead to the taking up of corresponding multiple doses of complement, and (*b*) that the complement taken up appeared to dissociate again in part, though this phenomenon might possibly be due to the presence of some complement molecules with very slow action. When, however, we used as the indicator *ox's corpuscles* treated with their corresponding immune-body, quite different results were obtained. The scheme is now :—

Guinea-pig's ○ + *n* IB + *x* rabbit's C ⋮ + Ox's ○ + IB.

The following results will serve as examples :—

Experiment LX.—1 D of IB	took up	0.2	c.c.	rabbit's C.
3	,,	,,	0·45	,,	,,
10	,,	,,	1·16	,,	,,

The M.H.D. of C was only 0·1 c.c. before the experiment; it is possible that it may have increased subsequently.

Experiment LXVIII.—2 D of IB	took up	0·28	c.c.	rabbit's C.	
5	,,	,,	0·58	,,	,,
10	,,	,,	0·74	,,	,,

The M.H.D. of C was 0·06 c.c.

It is thus seen that when ox's corpuscles suitably treated are used as the indicator, the amount of complement taken up increases as the amount of immune-body is increased, though there is a greater deviation from strict arithmetical proportion than when guinea-pig's complement is used.

The difference in the results obtained with the two indicators (guinea-pig's and ox's corpuscles respectively), is manifestly due to the fact that there is in the rabbit's serum a complement which acts on guinea-pig's corpuscles, and not on ox's corpuscles, and that this complement either becomes dissociated from the guinea-pig's corpuscles or combines in very small amount. On the other hand the *chief* complement present acts on both varieties, and its union is a firm one;

even with this combination, however, the amount taken up appeared to diminish somewhat over night.

The fact already stated that, when guinea-pig's corpuscles were used as the indicator, additional doses of immune-body did not appear to lead to the taking-up of additional amounts of complement, raised the question whether there might not be two immune-bodies present, one of which acted with rabbit's complement, and one with guinea-pig's complement. Evidence of this was sought for by leaving the immune-serum in contact with the corpuscles for a time, then separating by centrifugalisation, and thereafter testing the dose of the uncombined immune-body with rabbit's and with guinea-pig's complement respectively. It is evident that if two immune-bodies were present, and were taken up by the corpuscles in different proportions, then the relative doses of the separated fluid would become changed. Such an investigation is theoretically of simple nature, but it is difficult to carry it out exactly, owing to the fact that it is not possible to remove completely the natural immune-body from the rabbit's serum, *i.e.*, to make this serum entirely devoid of hæmolytic action. In several experiments, however, allowance being made for this circumstance, it appeared that the relative doses with the two complements did alter in the way that the dose with guinea-pig's complement became relatively still higher, *i.e.*, after the contact with the corpuscles there seemed to be immune-body molecules left, which acted with rabbit's, but not with guinea-pig's complement. This may mean merely that the molecules of immune-body vary in their combining affinities, and that those with the weaker affinity act with the more powerful complement (rabbit's). The question is one of great complexity, and we have not attempted a full solution, as it did not appear necessary for the purposes of the present research. Everything goes to show, however, that the great majority of the immune-body molecules act both with rabbit's and with guinea-pig's complement; and we found that the presence of a small amount of guinea-pig's complement kept out of combination a certain amount of rabbit's complement, and *vice versâ*.

(c) *With Ox's Complement*—

The ox's complement is not a very suitable one to employ in this combination, as the natural serum of the ox has a very powerful hæmolytic action in itself, and it is only possible to remove a small proportion of the natural immune-body by contact experiments. Nevertheless, we have found that the dose of ox's complement, along with the immune-body to guinea-pig's corpuscles, is a small one, and there is no doubt that guinea-pig's corpuscles are very sensitive to the zymotoxic action of ox complement.

When we come to investigate the combining affinities, we find that multiple doses of immune-body have very little effect on the amount of ox's complement taken up, the amount taken up by means of from four to eight doses, for example, being very little more than that taken up by means of one dose. This may be due to a true want of combining affinity on the part of the complement, or it may be due to the combination being a very loose one. It may be noted, however, that there is practically no evidence of dissociation of complement in the course of 12 hours. The following will serve as an example :—

Experiment LXXIV.—1 D of IB took up 0·04 c.c. of ox's C.
4 „ „ 0·042 „ „
8 „ „ „ „ „

The indicator was guinea-pig's corpuscles treated with immune-body, for which the dose of ox's complement was 0·02 c.c.

II. Immune-body to Rabbit's Corpuscles (obtained by injecting the Guinea-pig).

(a) *With Rabbit's Complement.*—

This case is in many ways analogous to that of the immune-body to guinea-pig's corpuscles along with guinea-pig's complement. In both cases the hæmolytic dose of immune-body is ten times greater when the complement of the animal whose corpuscles are being tested is used, than when the complement of the other animal is used. This will be seen from the table. In this case, also, the dose of rabbit's complement is high, just as in the previous case the dose of guinea-pig's complement was. How much rabbit's complement is taken up when multiple doses of immune-body are used? The scheme of experiment is:—

Rabbit's ○ + n IB + x rabbit's C ⋮ + Ox's ○ + IB.

The following are some of the results:—

Experiment LXII.—1 D of IB takes up 0·14 c.c. rabbit's C.
10 „ „ 1·16 „ „

„ LXIII.—1 D of IB takes up 0·22 c.c. rabbit's C.
10 „ „ 1·12 „ „

„ LXVI.—1 D of IB takes up 0·086 c.c. rabbit's C.
5 „ „ 0·55 „ „
10 „ „ 0·9 „ „

Dose of rabbit's C with rabbit's corpuscles = 0·6 c.c. "1 D" = M.H.D. of IB along with guinea-pig's C. "10 D" = M.H.D. with rabbit's C (*vide* tables).

It will be seen that there is no lack of combining-power on the part of rabbit's complement, and that the amount increases with the amount of immune-body, though considerable deviations from exact arithmetical proportions are met with. Sometimes more, proportionally, is taken up by 10 hæmolytic doses than by 1 hæmolytic dose, sometimes less; we have met with the former phenomenon in several other experiments than that quoted, and are not able to give at present an explanation of it. Another point is that the hæmolytic dose of immune-body (expressed as "10 D. of IB.") leads to the taking up of more than a

hæmolytic dose of rabbit's complement. This phenomenon is, probably, related to the fact brought out by Morgenroth and Sachs,* that the M.H.D. of complement sometimes varies greatly, according to the amount of immune-body used, and, conversely, the M.H.D. of immune-body may vary greatly, according to the amount of complement. The explanation of this is also outside the scope of the present paper.

(b) *With Guinea-Pig's Complement*—

The combination of guinea-pig's complement may be exemplified by the following:—

Experiment LXII.—1 D of IB took up 0·04 c.c. guinea-pig's C.
10 " " 0·36 " "

" LXIII.—1 D of IB took up 0·012 c.c. guinea-pig's C.
10 " " 0·27 " "

The indicator was ox's corpuscles treated with immune-body. Here we have variations corresponding to those noted above.

We have also found that with this immune-body a small quantity of guinea-pig's complement keeps out of combination a certain amount of rabbit's complement, and that saturation with rabbit's complement implies practical saturation for guinea-pig's complement also. A similar statement applies to rabbit's complement keeping out guinea-pig's complement.

(c) *With Ox's Complement*—

Owing to the lack of serum, we have been unable to study the combining relationships of ox's complement through the medium of this immune-body. This defect, however, cannot modify the main conclusions arrived at.

III. Immune-body to Ox's Corpuscles (obtained by injecting the Rabbit).

It will be seen from the tables above that the dose of immune-body is practically the same with guinea-pig's as with rabbit's complement. The dose of the latter complement is the higher, and in a previous paper† it was shown that this was probably due to a smaller number of complement molecules in a given volume of serum, rather than to a weaker action of the zymotoxic group. The combining relationships of the two complements have also been fully discussed there, so that it is unnecessary to repeat the results obtained. It is sufficient to say that they behave as regards combination in hæmolysis pretty much as if they had the same haptophore groups. We shall refer merely to the action of ox's complement along with the above immune-body.

With this combination it is usually impossible to produce more than a fraction of lysis in the corpuscles (usually not more than a tenth), no

* Morgenroth and Sachs, 'Berlin. klin. Woch.,' 1902, No. 35.

† Muir and Browning, 'Roy. Soc. Proc.,' June 9, 1904.

matter how large amounts of immune-body and complement are used; in only one case did we get a considerable amount of lysis, about three-fourths. We never obtained complete lysis, however. In other words, the ox's serum does not "complement." Is this due to want of combining power of the ox's complement, or to the deficiency of toxic action? This question can be answered by finding the amount of complement taken up when varying amounts of immune-body are used. The scheme is:—

$$\text{Ox's} \bigcirc + n\,\text{IB} + x \text{ ox's C} \;:\; \text{guinea-pig's} \bigcirc + \text{IB}.$$

As lysis does not occur in the first stage, the contents of each tube are centrifugalised, and the fluid is added to the guinea-pig's corpuscles. The following results were obtained:—

Experiment LXXIII.—	1 D of IB took up	0·04 c.c. ox's C.
	4 " "	0·05 " "
	8 " "	" " "

Dose of ox's complement for guinea-pig's corpuscles = 0·03 c.c.

Experiment LXXIV.—	1 D of IB took up	0·014 c.c. ox's C.
	4 " "	0·02 " "
	8 " "	" " "

Dose of ox's complement for guinea-pig's corpuscles = 0·02 c.c.

From these it is evident (1) that a considerable amount of ox's complement is taken up by one dose of immune-body (*i.e.*, by 1 M.H.D. as tested with rabbit's or guinea-pig's complement), but this amount of complement, which may be more than sufficient to produce complete lysis of rabbit's or guinea-pig's corpuscles, produces almost no lysis of the ox's corpuscles, and (2) the total amount of complement which can be taken up is almost reached with one dose of immune-body, additional doses of immune-body scarcely increasing the amount. There is, of course, in this case, no possibility of the phenomenon being due to dissociation of complement after combination, as the ox's corpuscles are removed by centrifugalisation before the guinea-pig's corpuscles are added, and, therefore, any complement obtainable must have been free in the fluid. Accordingly, we have here, again, an example of the relative non-sensitiveness of an animal's corpuscles to the action of its own complement when it is brought into union with them by an immune-body. But, in addition, there is, unlike the two previous cases, a deficiency also in the combining power of complement beyond a certain point, or, in other words, only a small proportion of the molecules of the red corpuscles combined with immune-body (R + IB molecules) take up ox's complement.

The fact that in the case just described, only some of the R + IB molecules take up complement is of considerable theoretical importance.

It is to be noted that almost all the R + IB molecules capable of taking up complement are present after the addition of one dose of immune-body, and that the subsequent addition of the same immune-body molecules scarcely increases the amount of complement taken up, though these molecules combine with the receptors of the red corpuscles. It would therefore appear that the failure on the part of an R + IB molecule to combine with complement, is due in some way to the receptors and not to the immune-body. According to Ehrlich's theory the amboceptor (immune-body) has practically no affinity for complement in the free state, but acquires that affinity when combined with the tissue or bacterial molecule. But the result above stated would, according to the amboceptor hypothesis, imply that only some molecules capable of combining with immune-body give the latter affinity for complement. According to the view that the immune-body renders the tissue molecule capable of taking up complement, the explanation would simply be that some of the molecules of the ox's corpuscles have no combining-group for the ox's complement, though they enter into combination with immune-body. It is not possible on theoretical grounds to establish either of these hypotheses by the exclusion of the other, but whichever may be ultimately established, the importance of the nature of the tissue molecule in determining whether complement will be taken up or not is brought out with sufficient clearness.

If we consider the action of guinea-pig's and rabbit's complements, it will appear that the striking variations in dosage brought out in the original tables, are due to the zymotoxic and not to the haptophore group. The combining relationships of the two complements may be compared in another way, viz., by adding a large amount of immune-body, say ten doses, and finding the ratio of rabbit's to guinea-pig's complement taken up in the case of the three sera. We have carried this out, and the following are the results. It was found most convenient to compare only two sera on the same day. Manifestly, only the two ratios in the same experiment are comparable.

			Ratio of two Cs.
Experiment LXX—			
Ox's corpuscles	10 D IB took up	0·44 c.c. guinea-pig's C	1 : 1·27.
,, ,, ...	,, ,,	0·56 ,, rabbit's C	
Guinea-pig's corpuscles..	,, ,,	0·48 ,, guinea-pig's C	1 : 1·17.
,, ,, ..	,, ,,	0·56 ,, rabbit's C	
Experiment LXXI—			
Ox's corpuscles	10 D IB took up	0·18 c.c. guinea-pig's C	1 : 2·6.
,, ,, ...	,, ,,	0·48 ,, rabbit's C	
Guinea-pig's corpuscles ..	,, ,,	0·28 ,, guinea-pig's C	1 : 2·1.
,, ,, ..	,, ,,	0·6 ,, rabbit's C	
Experiment LXXII—			
Ox's corpuscles	10 D IB took up	0·26 c.c. guinea-pig's C	1 : 1·4.
,, ,, ...	,, ,,	0·36 ,, rabbit's C	
Rabbit's corpuscles.	,, ,,	0·36 ,, guinea-pig's C	1 : 1·4
,, ,, ...	,, ,,	0·54 ,, rabbit's C	

It is thus seen that a comparatively close correspondence, considering the conditions of experiment, is brought out between the combining-ratios of the two complements in the case of these three sera.

The chief results may be summarised as follows :—

1. In the action of a complement there are two distinct factors, viz., (*a*) power of chemical combination, and (*b*) toxic action, corresponding to the "haptophore" and the "zymotoxic" groups of Ehrlich; deficiency in the action of complement (or in "complementing") does not necessarily imply want of combining affinity, but may be entirely due to the non-sensitiveness of the tissue-molecule to the zymotoxic group.

2. In the case of the three hæmolytic sera studied the outstanding fact is the large dose both of immune-body and of complement necessary when we use the complement of the same species of animal as that whose corpuscles are being tested.

3. In all three cases there is a relative non-sensitiveness of the corpuscles of the animal to the zymotoxic group of its own complement; hence a large dose of immune-body is requisite to bring into combination the amount of complement necessary for hæmolysis. In one case (that of the ox) there is also a deficiency in the combining power of the complement with the receptors of the red corpuscles united to immune-body; from the two conditions acting together complete hæmolysis cannot be obtained.

4. Although differences among the molecules of the same immune-serum may occur, we have found no evidence that the striking differences in the dosage of the immune-body with different complements, and also in the dosage of various complements, are due to multiplicity of immune-bodies.

No one has yet succeeded in producing an anti-substance or immune-body by injecting an animal with its own corpuscles or cells—such a body as with the aid of complement would produce destruction of these cells. This is manifestly a provision against self-poisoning, and Ehrlich has applied to it the term *autotoxicus horror*. The results which we have brought forward, if they were found to hold generally, would go to show that even if some substance should appear which acted as an immune-body, there is a provision whereby the complement of an animal should produce comparatively little harmful effect.